FORM PTO-1390 (REV 5-93) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 225/48700

U.S. APPLICATION NO (if known, see 37 CFR 1.5): 09/529365

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
19745124.1 EP98-0518	September 8, 1998	October 13, 1997

TITLE OF INVENTION
Electrically Controlled Valve

APPLICANT(S) FOR DO/EO/US ESPE-CHRISTOPH

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.

2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371

3. [ ] This express request to begin national examination procedures (35 U.S.C. 371(f) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. [X] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2)).

   a. [X] is transmitted herewith (required only if not transmitted by the International Bureau).

   b. [X] has been transmitted by the International Bureau

   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US)

6. [X] A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))

   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).

   b. [ ] have been transmitted by the International Bureau.

   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.

   d. [ ] have not been made and will not be made.

8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (Unexecuted)

10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Item 11. to 16. below concern other document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13. [X] A FIRST preliminary amendment.

    [ ] A SECOND or SUBSEQUENT preliminary amendment.

14. [X] A substitute specification.

15. [ ] A change of power of attorney and/or address letter.

16. [X] Other items or information:
International Preliminary Examination Report

U.S. APPLICATION NO (If known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/529365	19745124.1	225/48700

17. [ ] The following fees are submitted:

	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)):		
Search Report has been prepared by the EPO or JPO ..... $840.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) ..... $670.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482)	$840.00	
but international search fee paid to USPTO (37 CFR 1.445(a)(2) ..... $690.00 Neither international preliminary examination fee (37 CFR 1.482) nor	$0.00	
international search fee (37CFR 1.445(a)(2) paid to USPTO ..... $ 970.00 International preliminary examination fee paid to USPTO (37 CFR 1.482)		
and all claims satisfied provisions of PCT Article 33(2)-(4) $96.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$840.00	
Surcharge of $130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$130.00	

Claims	Number Filed	Number Extra	Rate		
Total Claims	14-20=	0	X $18.00	$0.00	
Independent Claims	2-3=	0	X $78.00	$0.00	
Multiple dependent claims(s) (if applicable)			+ $260.00	$	
TOTAL OF ABOVE CALCULATIONS =				$970.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$970.00	
Processing fee of $130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$970.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28,3.31). $40.00 per property +				$0.00	
TOTAL FEE ENCLOSED =				$970.00	
				Amount to be: refunded	$
				charged	$

a. [X] Two checks in the amount of $ 970.00 for the filing fee and $0.00 for the assignment recording fee are enclosed

b. [ ] Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees, which may be required, or credit any overpayment to Deposit Account No. 05-1323. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
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SIGNATURE

For Gary R. Edwards
NAME
31,824
REGISTRATION NUMBER
April 13, 2000
DATE

Attorney Docket: 225/48700
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: CHRISTOPH ESPEY

Serial No.: Not Yet Assigned PCT No. PCT/EP98/05682

Filed: April 13, 2000

Title: ELECTRICALLY CONTROLLED VALVE

PRELIMINARY AMENDMENT

Box Amendment
Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Please amend the above identified application as follows:

IN THE SPECIFICATION

Submitted herewith is a copy of a substitute specification and marked-up version.

IN THE CLAIMS

Please cancel all of the claims presently in the application and substitute new claims 8-21 as follows:

8. An electrically activated valve comprising:

a valve stem holding a valve member interacting with a valve seat on a valve housing;

a valve spring providing a force in a first direction on said valve;

a value guide for guiding said valve stem in said valve housing:

an activating device which, when activated, provides a force in a direction opposite said first direction to axially move said valve stem and said valve member in said valve housing and said valve member interacting with a valve seat on said valve housing to thereby determine flow through said valve;

an annular space formed between said valve guide and said valve member, said annular space providing a contact area between the valve member and the valve seat which is bounded on one side by a step adjoined by a guide surface.

9. The valve according to Claim 8, wherein the step and the guide surface are arranged on at least one of the valve member and the valve housing.

10. The valve according to Claim 8, wherein said step is formed by an edge of the valve member wherein said edge is surrounded by a separate baffle element which is connected to one of the valve housing and a stop which limits an opening stroke of the valve member.

11. The valve according to Claim 10, wherein said baffle element has radially oriented drainage passages for connecting a space adjoining the valve member to a return passage.

12. The valve according to one of Claims 10, wherein drainage passages are provided between the stop and the valve member.

13. The valve according to Claim 10, wherein the baffle element is secured on the valve housing by means of guide vanes which are arranged downstream of the baffle element.

14. The valve according to one of Claim 10, wherein the baffle element is formed on the stop and drainage passages are formed by holes.

15. A valve system, comprising:

a valve member having a valve stem;

a valve housing containing said valve stem and a valve seat;

a valve spring providing a biasing force in a first direction against said valve stem;

an activation device which, when activated, provides a force in a second direction opposite to said first direction to axially move said valve stem;

a valve guide for guiding said valve stem in said valve housing;

a contact area formed between the valve member and the valve seat, said contact area being bounded on one side by a step which is adjoined by a guide surface.

16. The arrangement according to claim 15, wherein the step and the guide surface are arranged on at least one of the valve member and the valve housing.

17. The arrangement according to claim 15, wherein the step is formed by the edge of the valve member and wherein the valve member is surrounded by a baffle element which is one of connected to the valve housing and to a stop in order to limit the opening stroke of the valve member.

18. The arrangement according to claim 17, wherein the baffle element has radially oriented drainage passages which connect a space adjoining the valve member to a return passage.

19. The arrangement according to claim 18, wherein a plurality of said drainage passages are provided between the stop and the valve member.

20. The arrangement according to claim 17, wherein the baffle element is secured on the valve housing by means of guide vanes arranged downstream of the baffle element.

21. The arrangement according to claim 17, wherein the baffle element is formed on the stop and drainage passages are formed by holes.

IN THE ABSTRACT:

Please substitute the new Abstract of the Disclosure submitted herewith on a separate page for the original Abstract presently in the application.

REMARKS

The claims 8-21 are fully supported by the originally filed specification and no new matter has been added.

Therefore, applicant respectfully requests a full and thorough examination on the merits of this application containing claims 8-21.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket #225/48700).

Respectfully submitted,

March 28, 2000

Gary R. Edwards
Registration No. 31,824
Vincent J. Sunderdick
Registration No. 29,004

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--ABSTRACT OF THE DISCLOSURE

An electrically activated valve has a device which, in the activated state and counter to the force of a valve spring, axially moves a valve stem with a valve member which interacts with a valve seat on a valve housing and determines the flow through the valve. The valve stem is guided in the valve housing and, with the valve housing, forms, between its guiding part and the valve member, an annular space into which a pressure passage opens. The contact area between the valve member and the valve seat is bounded at the outside by a step, which is adjoined by a guide surface.--

Attorney Docket: 225/48700
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: CHRISTOPH ESPEY

Serial No.: Not Yet Assigned

Filed: April 13, 2000

Title: ELECTRICALLY CONTROLLED VALVE

SUBMISSION OF SUBSTITUTE SPECIFICATION

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Attached is a Substitute Specification and a marked-up copy of the original specification. I certify that said substitute specification contains no new matter and includes the changes indicated in the marked-up copy of the original specification.

Respectfully submitted,

April 13, 2000

Gary R. Edwards
Registration No. 31,824
Vincent J. Sunderdick
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TITLE OF THE INVENTION

ELECTRICALLY CONTROLLED VALVE

BACKGROUND AND SUMMARY OF THE INVENTION

This application claims the priority of 19745124.1, filed October 13, 1997, the disclosure of which is expressly incorporated by reference herein.

The invention relates to an electrically activated valve which is actuated by electromagnets, piezoelectric elements and the like. Then valves are used in fuel injection systems for internal combustion engines. A feed pump feeds the fuel at a low pressure to the inlet side of a high-pressure pump, generally a mechanically driven piston pump, which injects the fuel at high pressure into the internal combustion engine via an injection valve. The quantity of fuel injected per operating cycle is limited by an electrically activatable valve establishing the connection between the pressure line of the injection pump and a return passage and thus restricting effective delivery by the injection stroke.

A valve of the generic type belonging to an injection system is known from German Patent DE 34 06 198 C2. The electromagnetically actuable valve has a valve seat, a valve stem with a guiding part, a valve member in the form of a valve plate,

an electromagnetic device and a valve spring. The valve stem is guided in an axially movable manner in a valve housing by means of a guiding part, an electromagnet pulling the valve member against a valve seat by means of an elastic element, against the force of the valve spring, in the excited state and the valve spring providing a limited opening of the valve member in the de-energized state of the electromagnet. The fuel is fed to the valve via a pressure passage which opens into an annular space between the valve seat and the guiding part. To ensure that no hydraulic forces act on the valve due to the fuel pressure, the guiding part has, in the direction of the annular space, an offset. The offset annular area of which corresponds essentially to the hydraulically effective diameter of the valve member, with the result that the pressure forces acting on the valve member cancel each other out at the valve stem.

Owing to wear due to solid particles in the fuel and cavitation and to a settling phenomena at the valve seat, the effective hydraulic diameter changes over time and disturbs the hydraulic equilibrium existing at the outset. This can, in turn, disrupt the operation of the valve to a considerable extent, with the result that precise discharge of the fuel is no longer assured.

German Reference DE 19 716 041 A1 has already proposed using geometrical measures to ensure that the effective hydraulic diameter is not increased or limited by wear and settling phenomena in comparison with the design condition. This is achieved, for example, by virtue of having only a slight overlap between the valve member and the valve seat. As a result, the small contact area remains relatively constant, even in the case of wear. However, it has been found that these measures disrupt flow conditions at the valve seat. As a result, either an increase in cavitation can be expected or dynamic response during opening of the valve will be impaired.

The object of the present invention is to improve flow conditions in the region of the valve seat without sacrificing the advantages described above. This is achieved by having the contact area between the valve member and the valve seat bounded at the outside by a step, which is adjoined by a guide surface. The step simultaneously limits the effective hydraulic diameter of the valve member, which thus remains constant over its entire life. The guide surface adjoining the step can be configured in such a way that the fluid is diverted to a return passage in an optimum manner, thus avoiding cavitation and the noise associated with it.

It is expedient if the step and the guide surface are formed directly on the valve member, e.g. by offsetting the region of the guide surface relative to the contact area on the valve member by shaping with or without machining. However, the step and the guide surface can also be provided on the valve housing. A combination of both measures can be used. These configurations are suitable both for proportional valves in which the opening stroke changes in proportion to a control variable and for switching valves, in which the valve member assumes just one defined closed or open position.

For switching valves, in which the opening stroke of the valve member is limited by a stop, it is expedient if the step is formed by the edge of the valve member, and a separate baffle element adjoins the edge of the valve member. The baffle element can be advantageously connected either to the valve housing, for example, by means of guide vanes, or to the stop which limits the opening stroke of the valve member. In this arrangement, the guide surface adjoins the contact area of the valve member in the open position of the valve member, allowing a favourable flow pattern to form.

It is also expedient if the space between the baffle element, the stop and the valve member, which the valve member enters during the opening stroke, is connected to the return

passage by radially oriented drainage passages to ensure that no hydraulic reaction occurs during the opening of the valve member. A specific level of damping of the valve can be achieved through the dimensioning of the drainage passages.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Further advantages will emerge from the following description of the drawings which detail illustrative embodiments of the invention.

Fig. 1 shows a schematic partial section through a valve according to the invention,

Fig. 2 shows an enlarged detail in accordance with the line II in Fig. 1,

Fig. 3-7 show variants of Fig.2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An electrically activated valve 1 can be activated by a device 3, which can be an electromagnet or a piezoelectric element. In the activated state, the device 3 provides a force which is counter to the force of a valve spring 4 on a valve stem 8 which is guided axially in a valve housing 2 by a guide 9. The valve spring 4 is accommodated in a spring chamber 5 and is supported at one end, via a washer 7, on the device 3, which is secured on the valve housing 2, and at the other end, via a spring plate 6, on the valve stem 8.

At the free end of the valve stem 8 there is a valve member 10 in the form of a valve plate which interacts with a valve seat 13 on the valve housing 2. A fluid, in the case of a fuel injection pump fuel, is fed to the valve 1 at high pressure via a pressure passage 12, which opens into an annular space 11 between the guiding part 9 and the valve member 10. In the open position shown, the fluid is drained off into a return passage 27. In this position, the valve spring 4 presses the valve member 10 against a stop 25.

As can be seen more clearly from Fig. 2, the valve member 10 overlaps the annular space 11 only slightly in the radial direction, resulting at the edge of the valve member 10 in a

narrow contact area 14, which is bounded at the outside by a step 15. According to Figs 2-5 and 7, the step 15 is formed by the edge 17 of the valve member 10, while, in the embodiment according to Fig. 6, the step 15 is formed by an offset in the valve member 10. Adjoining the step 15 is a guide surface 16 which optimizes the flow of the fuel to the return passage 27. The guide surface 16 can be formed directly on the valve member 10 (Fig. 6) or be part of a baffle element 18 which can be firmly connected to the stop 25 or be formed in one piece with it. It is furthermore possible to connect the baffle element 18 to the valve housing 2 (Fig. 7). This attachment can be expediently accomplished by guide vanes 26, which assist the action of the guide surface 16.

Formed between the valve member 10, the stop 25 and the baffle element 18 is a space 28 which is connected by drainage passages 19-24 to the return passage 27 in order to avoid an accumulation of the fuel in this space 28 when the valve 1 is opened. The drainage passages 19-24 can be of various configurations. Fig. 2, for example, shows a baffle element 18 which is firmly connected to the stop 25 and has drainage passages 19 between it and the stop 25. The valve member 10 furthermore has drainage passages 20 at the end. The drainage passage can be formed by slots or milled recesses.

In the configuration according to Fig. 3, the stop 25 has through drainage passages 21 which lead from the region of the valve member 10 to the return passage 27 via the region of the baffle element 18.

The drainage passages according to Figs 4 and 5 are formed by slots 24 or holes 22 in the baffle element 18, which are connected to the stop 25. In this arrangement, the hole 22 extends directly into the region of the end face of the valve member 10. Since, in the embodiment according to Fig. 7, the baffle element 18 is connected to the valve housing 2, the drainage passage 23 can be formed by an annular space between the baffle element 18 and the stop 25.

Because the embodiment according to Fig. 6 does not have a separate baffle element, no drainage passages are required. The fuel can escape between the end face of the valve member 10 and the stop 25 into the return line 27. In doing so, it does not hinder flow in the region of the valve seat.

The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include

everything within the scope of the appended claims and equivalents thereof.

TITLE OF THE INVENTION

ELECTRICALLY [ACTIVATABLE] CONTROLLED VALVE

BACKGROUND AND SUMMARY OF THE INVENTION

This application claims the priority of 19745124.1, filed October 13, 1997, the disclosure of which is expressly incorporated by reference herein.

The invention relates to an electrically [activatable] activated valve [in accordance with the precharacterizing clause of Claim 1.

Electrically activatable valves] which [are] is actuated by electromagnets, piezoelectric elements and the like. [are used, inter alia,] Then valves are used in fuel injection systems for internal combustion engines. [Here,] [a] A feed pump feeds the fuel at a low pressure to the inlet side of a high-pressure pump, generally a mechanically driven piston pump, which injects the fuel at high pressure into the internal combustion engine via an injection valve. The quantity of fuel injected per operating cycle is limited by an electrically activatable valve establishing the connection between the pressure line of the injection pump and a return passage and thus [ending] restricting effective delivery by the injection stroke.

A valve of the generic type belonging to an injection system is known from German Patent DE 34 06 198 C2. The electromagnetically actuable valve has a valve seat, a valve stem with a guiding part, a valve member in the form of a valve plate, an electromagnetic device and a valve spring. The valve stem is guided in an axially movable manner in a valve housing by means of a guiding part, an electromagnet pulling the valve member against a valve seat by means of an elastic element, [counter to] against the force of the valve spring, in the excited state and the valve spring providing a limited opening of the valve member [by a limited amount] in the de-energized state of the electromagnet. The fuel is fed to the valve via a pressure passage which opens into an annular space between the valve seat and the guiding part. To ensure that no hydraulic forces[, if any,] act on the valve due to the fuel pressure, the guiding part has, in the direction of the annular space, an offset[,]. [the] The offset annular area of which corresponds essentially to the hydraulically effective diameter of the valve member, with the result that the pressure forces acting on the valve member cancel each other out at the valve stem.

Owing to wear due to solid particles in the fuel and cavitation and to a settling phenomena at the valve seat, the effective hydraulic diameter changes [in the course of] over time and disturbs the hydraulic equilibrium existing at the outset.

[is no longer present.] This can, in turn, disrupt the operation of the valve to a considerable extent, with the result that precise discharge of the fuel is no longer assured.

German Reference DE 19 716 041 A1 has already proposed using geometrical measures to ensure that the effective hydraulic diameter is not increased or limited by wear and settling phenomena in comparison with the design condition. This is achieved, for example, by virtue of [the fact that] having only a slight overlap between the valve member and the valve seat. [have only a slight overlap.] As a result, the small contact area remains relatively constant, even in the case of wear. However, it has been found that these measures disrupt flow conditions at the valve seat. [are affected unfavourably by these measures, with the] As a result, either [that] an increase in cavitation can be expected or dynamic response during opening of the valve will be impaired.

The object [on which] of the present invention is [based is] to improve flow conditions in the region of the valve seat without [the need to sacrifice] sacrificing the advantages described above. [According to the invention, it is achieved by the features of Claim 1.
According to the invention,] This is achieved by having the contact area between the valve member and the valve seat [is]

bounded at the outside by a step, which is adjoined by a guide surface. The step simultaneously limits the effective hydraulic diameter of the valve member, which thus remains constant over its entire life. The guide surface adjoining the step can be configured in such a way that the fluid is diverted to a return passage in an optimum manner, thus avoiding cavitation and the noise associated with it.

It is expedient if the step and the guide surface are formed directly on the valve member, e.g. by offsetting the region of the guide surface relative to the contact area on the valve member by shaping with or without machining. However, the step and the guide surface can also be provided on the valve housing. A combination of both measures [is furthermore conceivable] can be used. These configurations are suitable both for proportional valves in which the opening stroke changes in proportion to a control variable and for switching valves, in which the valve member assumes just one defined closed or open position.

[In] For switching valves, in which the opening stroke of the valve member is limited by a stop, it is expedient if the step is formed by the edge of the valve member, and a separate baffle element adjoins the edge of the valve member. The baffle element can be advantageously connected either to the valve housing, [advantageously,] for example, by means of guide vanes,

or to the stop which limits the opening stroke of the valve member. In this arrangement, the guide surface adjoins the contact area of the valve member in the open position of the valve member, allowing a favourable flow pattern to form.

It is also expedient if the space between the baffle element, the stop and the valve member, which the valve member enters during the opening stroke, is connected to the return passage by radially oriented drainage passages to ensure that no hydraulic reaction occurs during the opening of the valve member. [The subclaims contain a number of variants on the embodiment of the drainage passages.] A specific level of damping of the valve can be achieved through the dimensioning of the drainage passages.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Further advantages will emerge from the following description of the drawings which detail [. The drawing shows] illustrative embodiments of the invention. [The description and

the claims contain numerous features in combination. The person skilled in the art will also expediently consider the features individually and combine them into worthwhile further combinations.

In the drawing:]

Fig. 1 shows a schematic partial section through a valve according to the invention,

Fig. 2 shows an enlarged detail in accordance with the line II in Fig. 1,

Fig. 3-7 show variants of Fig.2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An electrically [activatable] activated valve 1 can be activated by [means of] a device 3, which can be an electromagnet or a piezoelectric element. In the activated state, the device 3 [acts] provides a force which is counter to the force of a valve spring 4 on a valve stem 8 which is guided axially in a valve housing 2 by [means of] a [guiding part] guide 9. The valve spring 4 is accommodated in a spring chamber 5 and is supported at one end, via a washer 7, on the device 3, which is secured on the valve housing 2, and at the other end, via a spring plate 6, on the valve stem 8.

At the free end of the valve stem 8 there is a valve member 10 in the form of a valve plate which interacts with a valve seat 13 on the valve housing 2. A fluid, in the case of a fuel injection pump fuel, is fed to the valve 1 at high pressure via a pressure passage 12, which opens into an annular space 11 between the guiding part 9 and the valve member 10[,]. [and,] [in] In the open position shown, the fluid is drained off into a return passage 27. In this position, the valve spring 4 presses the valve member 10 against a stop 25.

As can be seen more clearly from Fig. 2, the valve member 10 overlaps the annular space 11 only slightly in the radial direction, resulting at the edge of the valve member 10 in a narrow contact area 14, which is bounded at the outside by a step 15. According to Figs 2-5 and 7, the step 15 is formed by the edge 17 of the valve member 10, while, in the embodiment according to Fig. 6, the step 15 is formed by an offset in the valve member 10. Adjoining the step 15 is a guide surface 16 which optimizes the flow of the fuel to the return passage 27. The guide surface 16 can be formed directly on the valve member 10 (Fig. 6) or be part of a baffle element 18[. This] which can be firmly connected to the stop 25 or be formed in one piece with it. It is furthermore possible to connect [it] the baffle element 18 to the valve housing 2 (Fig. 7)[,]. [this] This attachment

can be expediently [being] accomplished by [means of] guide vanes 26, which assist the action of the guide surface 16.

Formed between the valve member 10, the stop 25 and the baffle element 18 is a space 28 which is connected by drainage passages [21]19-24 to the return passage 27 in order to avoid an accumulation of the fuel in this space 28 when the valve 1 is opened. The drainage passages [21]19-24 can be of various configurations. Fig. 2, for example, shows a baffle element 18 which is firmly connected to the stop 25 and has drainage passages 19 between it and the stop 25. The valve member 10 furthermore has drainage passages 20 at the end[,]. The drainage passage can be [it being possible for these to be] formed by slots or milled recesses.

In the configuration according to Fig. 3, the stop 25 has through drainage passages 21 which lead from the region of the valve member 10 to the return passage 27 via the region of the baffle element 18.

The drainage passages according to Figs 4 and 5 are formed by slots 24 or holes 22 in the baffle element 18, which [is] are connected to the stop 25. In this arrangement, the hole 22 extends [right] directly into the region of the end face of the valve member 10. Since, in the embodiment according to Fig. 7,

the baffle element 18 is connected to the valve housing 2, the drainage passage 23 can be formed by an annular space between the baffle element 18 and the stop 25.

[Since] Because the embodiment according to Fig. 6 does not have a separate baffle element, no drainage passages are required. [here.] The fuel can escape between the end face of the valve member 10 and the stop 25 into the return line 27. In doing so, it does not hinder flow in the region of the valve seat.

The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.

Daimler-Benz-Aktiengesellschaft
Stuttgart

Electrically activatable valve

The invention relates to an electrically activatable valve in accordance with the precharacterizing clause of Claim 1.

Electrically activatable valves which are actuated by electromagnets, piezoelectric elements and the like are used, inter alia, in fuel injection systems for internal combustion engines. Here, a feed pump feeds the fuel at a low pressure to the inlet side of a high-pressure pump, generally a mechanically driven piston pump, which injects the fuel at high pressure into the internal combustion engine via an injection valve. The quantity of fuel injected per operating cycle is limited by an electrically activatable valve establishing the connection between the pressure line of the injection pump and a return passage and thus ending effective delivery by the injection stroke.

A valve of the generic type belonging to an injection system is known from DE 34 06 198 C2. The electromagnetically actuable valve has a valve seat, a valve stem with a guiding part, a valve member in the form of a valve plate, an electromagnetic device and a valve spring. The valve stem is guided in an axially movable manner in a valve housing by means of a guiding part, an electromagnet pulling the valve member against a valve seat by means of an elastic element, counter to the force of the valve spring, in the excited state and the valve spring opening the valve member by a limited amount in the de-energized state of the electromagnet. The fuel is fed to the valve via a pressure passage which opens into an annular space between the valve seat and the guiding part. To ensure that no hydraulic forces, if any, act on the valve due to the fuel pressure, the

guiding part has, in the direction of the annular space, an offset, the annular area of which corresponds essentially to the hydraulically effective diameter of the valve member, with the result that the pressure forces acting on the valve member cancel each other out at the valve stem.

Owing to wear due to solid particles in the fuel and cavitation and to settling phenomena at the valve seat, the effective hydraulic diameter changes in the course of time and the hydraulic equilibrium existing at the outset is no longer present. This can disrupt the operation of the valve to a considerable extent, with the result that precise discharge of the fuel is no longer assured.

DE 19 716 041 A1 has already proposed using geometrical measures to ensure that the effective hydraulic diameter is not increased or limited by wear and settling phenomena in comparison with the design condition. This is achieved, for example, by virtue of the fact that the valve member and the valve seat have only a slight overlap. As a result, the small contact area remains relatively constant, even in the case of wear. However, it has been found that flow conditions at the valve seat are affected unfavourably by these measures, with the result that an increase in cavitation can be expected or dynamic response during opening of the valve will be impaired.

The object on which the invention is based is to improve flow conditions in the region of the valve seat without the need to sacrifice the advantages described above. According to the invention, it is achieved by the features of Claim 1.

According to the invention, the contact area between the valve member and the valve seat is bounded at the outside by a step, which is adjoined by a guide surface. The step simultaneously limits the effective hydraulic diameter of the valve member, which thus remains constant over its

entire life. The guide surface adjoining the step can be configured in such a way that the fluid is diverted to a return passage in an optimum manner, thus avoiding cavitation and noise associated with it.

It is expedient if the step and the guide surface are formed directly on the valve member, e.g. by offsetting the region of the guide surface relative to the contact area on the valve member by shaping with or without machining. However, the step and the guide surface can also be provided on the valve housing. A combination of both measures is furthermore conceivable. These configurations are suitable both for proportional valves in which the opening stroke changes in proportion to a control variable and for switching valves, in which the valve member assumes just one defined closed or open position.

In switching valves, in which the opening stroke of the valve member is limited by a stop, it is expedient if the step is formed by the edge of the valve member, and a separate baffle element adjoins the edge of the valve member. The baffle element can be connected either to the valve housing, advantageously, for example, by means of guide vanes, or to the stop which limits the opening stroke of the valve member. In this arrangement, the guide surface adjoins the contact area of the valve member in the open position of the valve member, allowing a favourable flow pattern to form.

It is expedient if the space between the baffle element, the stop and the valve member which the valve member enters during the opening stroke is connected to the return passage by radially oriented drainage passages to ensure that no hydraulic reaction occurs during the opening of the valve member. The subclaims contain a number of variants on the embodiment of the drainage passages. A specific level of damping of the valve can be achieved through the dimensioning of the drainage passages.

Further advantages will emerge from the following description of the drawing. The drawing shows illustrative embodiments of the invention. The description and the claims contain numerous features in combination. The person skilled in the art will also expediently consider the features individually and combine them into worthwhile further combinations.

In the drawing:

Fig. 1 shows a schematic partial section through a valve according to the invention,

Fig. 2 shows an enlarged detail in accordance with the line II in Fig. 1,

Fig. 3-7 show variants of Fig.2.

An electrically activatable valve 1 can be activated by means of a device 3, which can be an electromagnet or a piezoelectric element. In the activated state, the device 3 acts counter to the force of a valve spring 4 on a valve stem 8 which is guided axially in a valve housing 2 by means of a guiding part 9. The valve spring 4 is accommodated in a spring chamber 5 and is supported at one end, via a washer 7, on the device, which is secured on the valve housing 2, and at the other end, via a spring plate 6, on the valve stem 8.

At the free end of the valve stem 8 there is a valve member 10 in the form of a valve plate which interacts with a valve seat 13 on the valve housing 2. A fluid, in the case of a fuel injection pump fuel, is fed to the valve 1 at high pressure via a pressure passage 12, which opens into an annular space 11 between the guiding part 9 and the valve member 10, and, in the open position shown, is drained off into a return passage 27. In this position, the valve spring 4 presses the valve member 10 against a stop 25.

As can be seen more clearly from Fig. 2, the valve member 10 overlaps the annular space 11 only slightly in the radial direction, resulting at the edge of the valve member 10 in a narrow contact area 14, which is bounded at the outside by a step 15. According to Figs 2-5 and 7, the step 15 is formed by the edge 17 of the valve member 10, while, in the embodiment according to Fig. 6, the step 15 is formed by an offset in the valve member 10. Adjoining the step 15 is a guide surface 16 which optimizes the flow of the fuel to the return passage 27. The guide surface 16 can be formed directly on the valve member 10 (Fig. 6) or be part of a baffle element 18. This can be firmly connected to the stop 25 or be formed in one piece with it. It is furthermore possible to connect it to the valve housing 2 (Fig. 7), this expediently being accomplished by means of guide vanes 26, which assist the action of the guide surface 16.

Formed between the valve member 10, the stop 25 and the baffle element 18 is a space 28 which is connected by drainage passages 21-24 to the return passage 27 in order to avoid an accumulation of the fuel in this space 28 when the valve 1 is opened. The drainage passages 21-24 can be of various configurations. Fig. 2, for example, shows a baffle element 18 which is firmly connected to the stop 25 and has drainage passages 19 between it and the stop 25. The valve member 10 furthermore has drainage passages 20 at the end, it being possible for these to be formed by slots or milled recesses.

In the configuration according to Fig. 3, the stop 25 has through drainage passages 21 which lead from the region of the valve member 10 to the return passage 27 via the region of the baffle element 18.

The drainage passages according to Figs 4 and 5 are formed by slots 24 or holes 22 in the baffle element 18, which is connected to the stop 25. In this

arrangement, the hole 22 extends right into the region of the end face of the valve member 10. Since, in the embodiment according to Fig. 7, the baffle element 18 is connected to the valve housing 2, the drainage passage 23 can be formed by an annular space between the baffle element 18 and the stop 25.

Since the embodiment according to Fig. 6 does not have a separate baffle element, no drainage passages are required here. The fuel can escape between the end face of the valve member 10 and the stop 25 into the return line 27. In doing so, it does not hinder flow in the region of the valve seat.

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Stuttgart

Patent claims

1. Electrically activatable valve with a device which, in the activated state and counter to the force of a valve spring, axially moves a valve stem with a valve member which interacts with a valve seat on a valve housing and determines the flow through the valve, the valve stem being guided in the valve housing and, with the valve housing, forming between its guiding part and the valve member an annular space into which a pressure passage opens, characterized in that the contact area (14) between the valve member (10) and the valve seat (13) is bounded at the outside by a step (15), which is adjoined by a guide surface (16).

2. Valve according to Claim 1, characterized in that the step (15) and the guide surface (16) are arranged on the valve member (10) and/or on the valve housing (2).

3. Valve according to Claim 1, characterized in that the step is formed by the edge of the valve member (10), which is surrounded by a separate baffle element which is connected to the valve housing (12) or to a stop (25) which limits the opening stroke of the valve member (10).

4. Valve according to Claim 3, characterized in that the baffle element (18) has radially oriented drainage passages (19, 21, 22, 23, 24) which connect a space (28) adjoining the valve member (10) to a return passage (27).

5. Valve according to one of Claims 3 or 4, characterized in that drainage passages (20, 21) are provided between the stop (25) and the valve member (10).

6. Valve according to one of the preceding claims, characterized in that the baffle element (18) is secured on the valve housing (2) by means of guide vanes (26) which are arranged downstream of the baffle element (18).

7. Valve according to one of Claims 1 to 5,

characterized in that the baffle element (18) is formed on the stop (25), and the drainage passages are formed by holes (22).

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Abstract

1. The invention relates to an electrically activatable valve with a device which, in the activated state and counter to the force of a valve spring, axially moves a valve stem with a valve member which interacts with a valve seat on a valve housing and determines the flow through the valve, the valve stem being guided in the valve housing and, with the valve housing, forming between its guiding part and the valve member an annular space into which a pressure passage opens.

The proposal is that the contact area between the valve member and the valve seat is bounded at the outside by a step, which is adjoined by a guide surface.

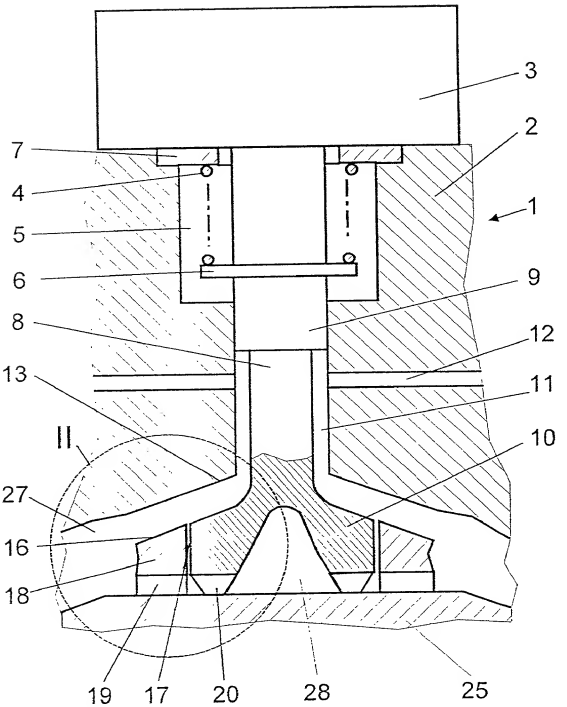

Fig. 1

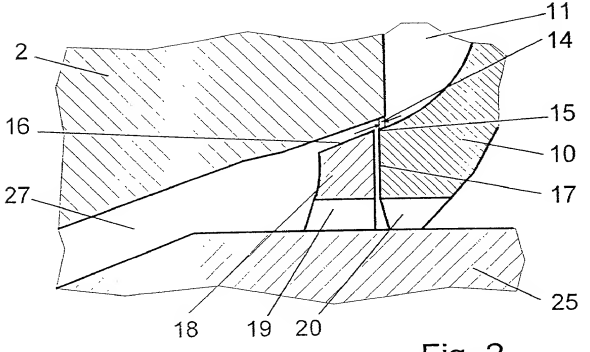

Fig. 2

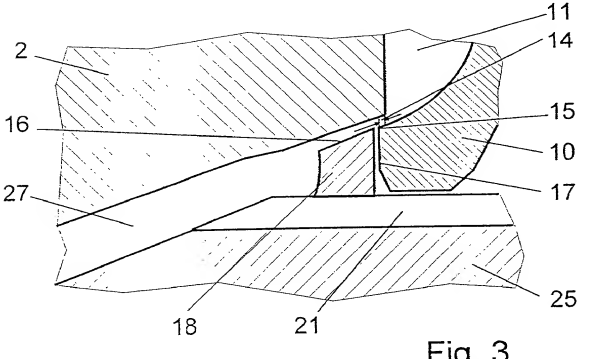

Fig. 3

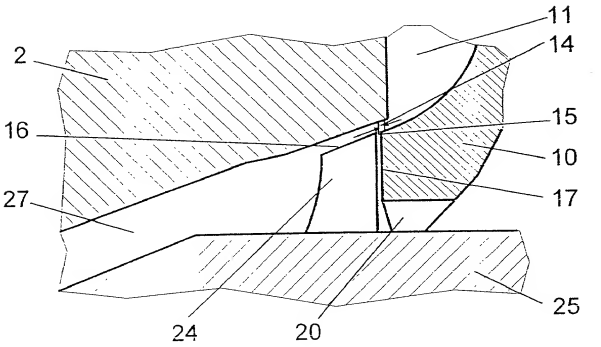

Fig. 4

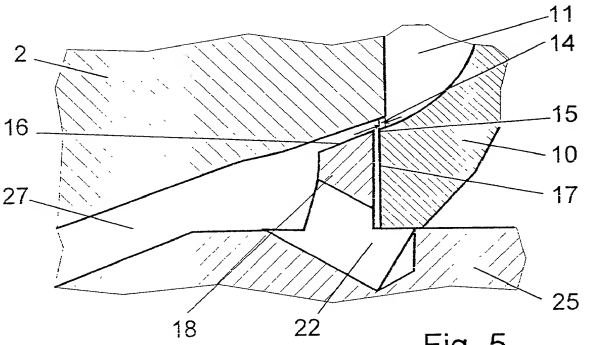

Fig. 5

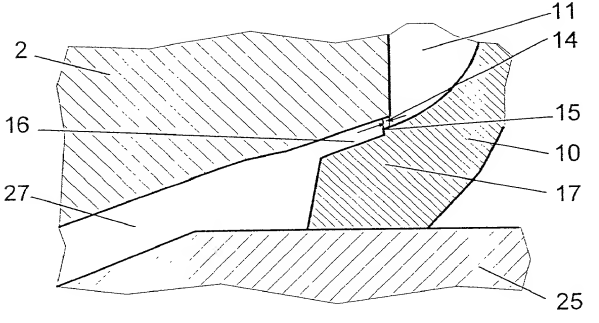

Fig. 6

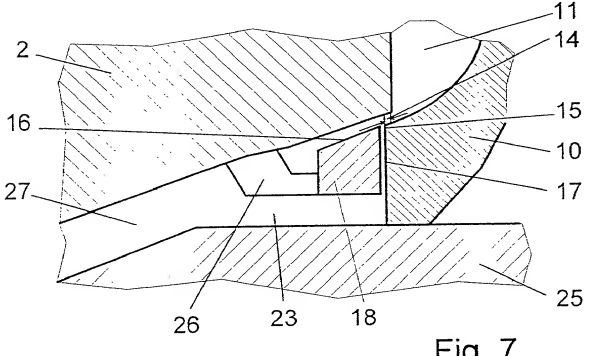

Fig. 7

2000

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY
(includes Reference to PCT International Applications)

ATTORNEY'S DOCKET NUMBER
225/48700

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

ELECTRICALLY ACTIVATABLE VALVE

the specification of which (check only one item below).

[ ] is attached hereto.

[ ] was filed as United States application
Serial No. _____
on _____
and was amended
on _____ (if applicable).

[X] was filed as PCT international application
Number PCT/EP98/05682
on September 8, 1998
and was amended under PCT Article 19
on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations. §1.56(a).

I hereby claim foreign priority benefits under Title 35, United State Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT indicate PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
Germany	197 45 124.1	13 October 1997	[X] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No
			[ ] Yes [ ] No

Combined Declaration For Patent Application and Power of Attorney (Continued)
(includes Reference to PCT international Applications

ATTORNEY'S DOCKET NUMBER
225/48700

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national of PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120

U.S. APPLICATIONS		STATUS *(Check one)*		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED (IF ANY)			

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

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	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY
203	FULL NAME OF INVENTOR	FAMILY NAME	FIRST GIVEN NAME	SECOND GIVEN NAME
	RESIDENCE & CITIZENSHIP	CITY	STATE OR FOREIGN COUNTRY	COUNTRY OF CITIZENSHIP
	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true: and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
Christoph Espey		
DATE 6.6.00	Date	DATE